Productivity Spillover of Resource Exploitation: Evidence from Venezuelan Industrial Surveys*

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Abstract

The role played by natural resources in development has been part of the economic policy debate for some time. One of the issues that have risen the most interest is industrial development. On side there is evidence that there is "Dutch Disease". On the other hand, there has been an important amount of literature highlighting the positive spillovers that the resource sector could have. In this paper we empirically review the role played by the Venezuelan oil sector in fostering productivity in the manufacturing sector. We use the Manufacturing Survey of Venezuela to find productivity spillovers from the resource sector. We found impacts of the oil sector in productivity. There are direct effects as well as spillovers. Also, we found that the oil sector will impact the likelihood and amount invested in R&D

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The role played by natural resources in development has been part of the economic policy debate for some time. From the works of Prebisch (1950) and Salter (1959) to the works by Sachs and Warner (1995 and 1997), there has been a perception that resource abundance was bad for development.[1] Nevertheless, a problem with this literature is the lack of evidence on the precise channels that produces this negative effect. In other words, there is a stylized fact.[2] There are some potential hypotheses to explain why this phenomenon is occurring. Nevertheless, the evidence about these explanations is weaker.

On of the issues that have risen the most interest is industrial development. Probably the best proved fact is that there is "Dutch Disease". Sijins (2003) uses a gravity model of trade and finds evidence on Dutch Disease. For a 1% increase in energy prices for the exporters of energy goods, there is a decline of 0.6% of manufacturing exports. However, the author does not find similar effects of price increases on other commodities, such as metals.

Furthermore, the fact that there is Dutch Disease does not imply dynamic effects on growth and, consequently, no effects of welfare.[3] For that reason, some authors have argued about these dynamics effects. Probably the best know work is Krugman (1997). In his paper he assumes that there is learning-by-doing in the manufacturing sector. Consequently, when a price booms causes one sector to become less competitive, it could be lost for ever. However, there is not strung empirical evidence on this fact. In their papers, Sachs and Warner (1995 and 1987) find a negative impact of resource abundance in 1970 on manufacturing exports in 1970. However, they do not text what happens to those exports after 1970.

On the other hand, there has been an important amount of literature highlighting the positive spillovers that the resource sector could have. Wright and Czelusta (2002) describe the experience of developed countries that had important endowments of natural resources in the past. A case they cite is the United States in the late nineteenth century and early twentieth century. They highlight the role of externalities and complementarities of the resource as key to a viable development path. In particular the focus on copper mines in the US which produced between 1900 and 1914 was 10 times higher that Chilean ones, in spite of the better geological conditions of the later. The point out hoe technology increased the resource base of the economy.

The authors argue that the key elements were: an appropriate institutional framework around the resource sector, the generation of a "free-access" knowledge capital ant the development of educational programs in mining and metallurgy. The authors argue that these factors were important to enable the complementarities between the productive and learning processes that foster technological progress. Therefore, they argue that

[1] Though the work of Salter (1959) per se does not attribute any negative effect to natural resources is the reference used to characterize the "Dutch Disease". This term is used to describe the "de-industrialization" of a country after a resource boom. The term was coined by the magazine *The Economist* in a article about the Netherlands ("The Dutch Disease", The Economist, November 26, 1977, pp 82-83)

[2] However, some recent works have cast some doubts even about these stylized claims. See for example the collection of papers edited by Lederman and Maloney (2006)

[3] In the "pure" Dutch Disease model, people are richer and consequently, can afford to buy more goods from abroad.

investment in knowledge is an important piece for resource abundant economies to avoid falling behind.

Blomström and Kokko (2002) describe the development path followed by Sweden and Finland from resource based economies towards technology-intensive manufacturing products. The highlight the institutional framework around the resource sector, the role played by Foreign Direct Investment (FDI) in bringing knowledge and technology, the international exposure of local entrepreneurs, the commitment of firs to invest in Research and Development (R&D), and the generation of a knowledge cluster. The authors conclude that the key issue is to foster and environment that allows firm to adapt when the market changes and use technological innovations.

However, we see again that the presence of complementary human capital fosters technological progress. Maloney (2002) describes the experience of Australia, which again is another resource rich developed economy. The author again finds the elements described in the previous cases –knowledge capital, resource institutions, human capital- as the main elements behind the Australian economic performance

In that same work, Maloney also reviews the Latin American experience. In this regard the author points how the region precisely lacked most of these elements. The region did not generate an environment that would have fostered innovation; there were little investment in human capital and little interest in knowledge capital. However the author also points out the diversification strategy. Latin America did not only engage in import-substitution, but also did not take advantage of the resource sector. Basically, there was vision of the resource sector as the center of a cluster that would have developed a non-resource sector.

In this paper we empirically review the role played by the Venezuelan oil sector in fostering productivity in the manufacturing sector. We use the Manufacturing Survey of Venezuela to find productivity spillovers from the resource sector. We also test if the resource sector fosters investment in R&D.

The paper is organized as follows: Section 1 presents an overview of the debate and research done on the role of oil in the development of the manufacturing sector in Venezuela. Sections 2 and 3 will then estimate the impact of the oil sector on productivity and R&D investment in manufacturing firms in Venezuela, respectively. Finally, Secion 4 concludes.

1. Oil and Industrial Development in Venezuela

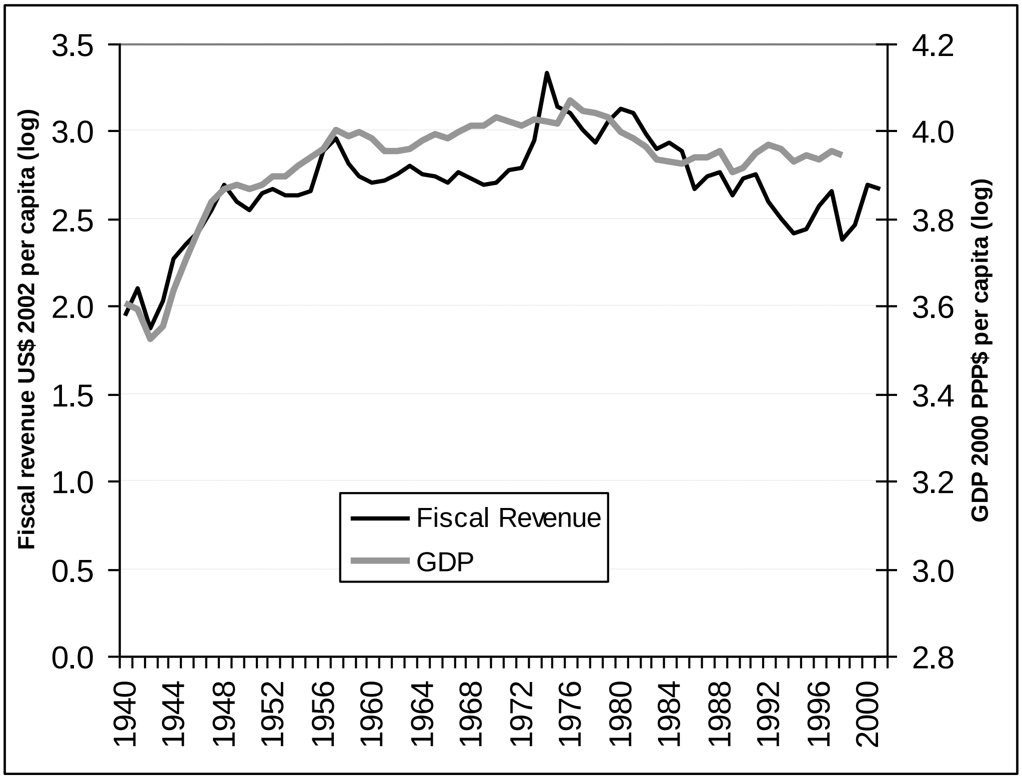
Oil has been extracted in Venezuela since the early twentieth century. As argued in Hausmann and Rodriguez (2009) Looking at the performance of oil fiscal revenue in Venezuela and GDP, it is apparent that both variables move closely together, as shown in Figure 1.[4] Real fiscal income per capita grew more or less steadily up to the early seventies, in line with GDP per capita.[5] Furthermore, both variables even change the slope of such growth around the same time in the late forties. After the mid seventies both variables collapsed.

[4] The correlation in levels is 0.84 and in differences 0.91. The graph is presented in logarithm to have a better assessment of growth rates.

[5] The spike in 1957 was due to the income generated by the selling of new rights to explore and produce oil at the end of the dictatorship of Marco Perez Jimenez.

Is not the purpose of this paper to explain the evolution of the Venezuelan economy. Hausmann (2003) presents a description and possible explanation for the economic performance of Venezuela. However, in that same article, Hausmann describes the impressive growth of Venezuela until the mid 1970's and the fundamentals behind that growth. Among them was the important accumulation of both human and physical capital. As Hausmann (2003) describes in a span of 25 years, the total years of education of women 25 or older duplicated.

Figure 1. Oil Fiscal revenue per capita and GDP per capita



Source: Author's calculations based on MEM (various years), Hausmann and Rodriguez (2005), and IMF(2004)

Most of this expansion has been attribute to oil. More precisely, with the onset of democracy in 1958, different administrations began expending more in education and health, thanks to the important revenues generated by the oil sector.[6] This led to an increase in the coverage of educational and health service. Therefore, from a historical point of view, oil revenue has played an important role in the development of Venezuela.

Nevertheless, with the collapse of oil revenue and the collapse of the Venezuelan economy, other issues are emerging and, consequently other effects of the sector on the Venezuelan economy has been discussed. Most of them are related to the political economy and institutional arrangements of the country.[7]

[6] See Manzano (2009) for a description of this process. As argued in that work, there was even a political principle that oil revenue must be "invested" in the people.

[7] See Hausmann (2003)

This debate has lost sight on the microeconomic issues related to oil exploitation. In particular it has not considered the local impacts of oil activity on the Venezuelan economy. This is relevant, because Venezuela has experience an important geographic change on the location of oil activity. Also, Venezuela has undergone important institutional changes, in terms of its federal governance. The study of these effects could help understand better the role played by oil in the collapse of the Venezuelan economy.

With regards to the industrial sector, Venezuela has performed poorly. We already mentioned that Maloney (2004) discussed how Latin America has missed the opportunity to use the resource sector to develop a non-resource sector. In Figure 2 we present the evolution of manufactures exports for East Asia, Latin America and Venezuela. We see that Latin America is less diversified that East Asia. However, we also see that Venezuela is even less diversified than Latin America. In Manzano (2009) Venezuela is compared to other oil producing countries and is less diversified that the mean of the group.

Figure 2

In this regard, there has been a long dated debate on the negative effects of the sector. In general oil has been perceived as an enclave and the view has been that Venezuela should diversified "away" of the sector. Most of the Venezuelan intellectuals warned about the problems that this temporary boom could cause on other productive sectors that later could not have been reverted when oil disappeared -basically using the argument of what currently is referred to in literature as the *Dutch disease*.[8] These led to the one of the guiding principles of the Venezuelan oil policy: the "sowing of oil". The

[8] Alberto Adriani (see for example, Adriani, 1931) was one of the authors that gave the most warnings about the end of the "agrarian era" for Venezuela, because of the presence of oil. However, other works (for example Mayobre, 1944, and Peltzer, 1944) discussed about the problems of an appreciated exchange rate on the industrialization of Venezuela.

"sowing of oil" implied that, given that oil is a temporary activity, the income coming from such activity should be invested in other sectors of the economy to diversify it. Its name came from an editorial published in 1936 by Arturo Uslar Pietri, an influential writer and intellectual.

In Manzano (2009) the different ways this "sowing of oil" was interpreted is described. However, in general there was not vision of the sector as the center of a cluster.It is important to mention that there was the idea that Venezuela has to get a higher share of the value added in the oil market. The Hydrocarbons Law of 1943 encouraged the domestic refining of oil and was key to the development of the current refining network in Venezuela. In 1958, the installed refining capacity was of 883 thousands of barrels a day, and the total of crude refined that year was 10 times higher than in 1943. Additionally, in 1956 the government established the Venezuelan Institute of Petrochemicals, with the idea of fostering the development of a Petrochemical sector. During this time, import substitution policies were in full swing in Latin America.[9] Therefore, these industrialization attempts around oil, more than reflecting a "cluster vision" of the sector, were just part of a wider set of policies aiming to produce the most of the goods imported by the country.[10]

In this regard, Celmente et al (2004) analyzes the impact of a resource sector on industrial productivity. The authors use industrial survey data from Venezuela to test the effect of being linked to that sector on productivity. They found that industrial sectors linked "up-stream" –suppliers- have lower productivity than other industries. On the other hand, sectors linked "down-stream" –buyers- have higher productivity than other industries. However, their estimation is based on aggregates at the local –state- level. They use 3 digits "clusters" at the state level. This data set has the disadvantage that does not use the full information of the Manufacturing Survey. The data set also does no allow for a good estimation of productivity using algorithms such as the Olley-Pakes (1996). Finally, the authors do no consider the possibility of productivity spillovers.

In this paper we take advantage of that the Venezuelan Manufacturing Survey has been recently processed by Pineda and Rodriguez (2006) and allowed to have firm level data. Also we will estimate spillovers.

NOTE TO THE REVIEWER: For the conference we will have documented more policy interventions specific to the oil sector.

2. Productivity Spillovers

We use a similar panel data of the Venezuelan Manufacturing Survey (Encuesta Industrial de Venezuela) processed by Pineda and Rodriguez (2006) and derived from

[9] See Maloney (2002)

[10] According to OCEPRE (1988) between 1964 and 1973, between 9 to 13% of the budget went to the "support of productive sectors" –net of infrastructure spending-, which indicates an active intervention of government in the economy. However, more than 60% went to agriculture, which indicates that government priorities were in other economic sectors.

Another evidence of the relative lack of a comprehensive policy towards the integration of the oil sector in the Venezuelan economy was the state of technical education related to oil. Geology -as a career- was not introduced until 1937 and Petroleum Engineering until 1952. By the time, most of the universities in the country were run by the government.

the Venezuelan Statistics Bureau. The choice of period is 1989-2001. The data contents a random sample of all plants in Venezuela. In that sense, annual survey includes firms that were surveyed in each of the thirteen years periods and firms that has not information for at least one year. Due to the variation of number of plants that were surveyed year after year we decided to construct a balanced panel. In addition, both aggregates variables and oil variables were incorporate into the Industrial Survey Database panel to explore the impact of oil sector on firm-level productivity.

Following the approach of Blyde et al (2004) and Pineda and Rodriguez (2006), we would like to estimate several variations of a firm level production function of firm i at time t

$$y_{it} = \alpha_0 + \alpha_1 k_{it} + \alpha_2 l_{it} + \alpha_3 ci_{it} + \omega_{it} \quad (1)$$

where is y_{it} log of real output , k_{it} the log of the plant's capital stock, l_{it} is employment, ci_{it} real intermediate input expenditure, while ω_{it} is plant level productivity. Like we do not observe the productivity term we decided to apply the well-known Olley-Pakes (1996) method to get it. We implement Olley-Pakes algorithm in three steps. In the first step, we find the coefficients of the production expression as a function the observables variables. In the second step of the method, we calculate using a probit model the exit probability for each firm to control the selection problem. Finally but no least, in the third step, we estimate the production coefficients on capital stock and real intermediate input expenditure through a nonlinear square regression. After that we are able to calculate the unknown term.

In the same way and taking advance of a similar specification made by Pineda and Rodriguez (2006), we run $\omega_{it} = a_0 + a_1\omega_{it-1} + a_2 f_{it} + \chi_i + v_{it}$ which can be estimated using the Arrellano and Bond (1991) techniques. Where f_{it} includes the spillovers from oil sector to domestic manufacturers. To analyze the spillovers from oil sector in manufacturing in our exercise, we have different variables that measures the direct and indirect effects of oil sector that allow us to examine the correlation between productivity at plant-level and oil sector. We follow closely the approach of Blyde et al (2004) to create these measures, both oil direct effects within the firm's industry accounts for horizontal spillovers and two variables to aggregate oil effects to downstream and upstream sectors, knows as forward and backward linkages. To do that we used the Imput-Output matrix (at the three-digit ISIC level) entries derived from the Venezuelan Central Bank, while the Oil production data comes from the Ministry of Energy for its yearly statistical survey.

Following the approach taken by Blyde et al (2004) we construct Horizontal spillover which captures the oil presence in the sector of the firm as follows :

$$Horizontal_{jt} = \left\lfloor \sum_{i \forall i \in j} CO_{ijt} Y_{ijt} \right\rfloor / \sum_{i \forall i \in j} Y_{ijt} \quad (2)$$

where CO_{ijt} measures the share of oil consumption in firm's, while Y_{ijt} represent the firm i's real gross output at time t.

In that sense, the variable forward is defined in the following way:

$$Forward_{jt} = \sum_{k \text{ if } k \neq j} \delta_{kj} Horizontal_{kt} \quad (3)$$

where δ_{kj} represents the fraction of sector k output supplied to sector j which was taken from the input-output matrix at the three-digit ISIC level.

Finally but not least, we measured the backward link as follow:

$$Backward_{jt} = \sum_{k \text{ if } k \neq j} \delta_{jk} Horizontal_{kt} \quad (4)$$

where δ_{jk} this time represents the fraction of sector j output supplied to sector k which was taken from the input-output matrix at the three-digit ISIC level. It is important to point out that the fraction was calculated without products supplied for final consumption due that these effect will be represented by the Horizontal variable.

The variables mentioned above also were incorporated into the main specification of the plant-level production to get the following equation:

$$y_{it} = \alpha_0 + \alpha_1 k_{it} + \alpha_2 l_{it} + \alpha_3 ci_{it} + \alpha_4 Horizontal_{jt} + \alpha_5 Forward_{jt} + \alpha_6 Backward_{jt} + \varepsilon_{ijrt}$$

This specification was estimated using ordinary least squares and both time and regional fixed effect. Also we run regressions with the Olley-Pakes correction to avoid the estimation bias when we use OLS.

Table 1, presents the results when we use the Blyde et al. (2004) specification. We present the regressions using the production function and the Olley-Pakes correction. We also present the regressions in levels and in first differences. [11] The first result the comes form the Table is that fuel consumption -which as we explained is more that fuel for energy, it could also be oil as an input- has negative effects in productivity and the result in consistent across different specifications.

However, the evidence on productivity spillovers from these firms in not conclusive. The signs and significance of the coefficient changes from estimation to estimation. Consequently, even though there is a negative impact of productivity of using oil products as input, this negative impact is not “transmitted” to other firms.

As we explained, we do no have the direct purchases of manufacturing firms to PDVSA. However we do have sector numbers. Looking at PDVSA’s suppliers, the results that is consistent across specifications is that there are negative forward productivity spillovers. In other words, supplies of PDVSA transmit a negative productivity shocks to its costumers and all their linkages “downstream”.

[11] In the appendix we show that we also did this regression with large firms only. The Venezuelan Industrial Survey is a Census of large firms and a survey for the others. The results from these estimation hold in the sample of large firms.

Table 1: Productivity and Oil. Blyde et al (2004) approach

All Plants	Levels						1st Differences				
	Production Function			O-P			Production Function			O-P	
Intermediate Consumption	0.743***	0.756***	0.755***				0.484***	0.533***	0.533***		
	(0.000)	(0.000)	(0.000)				(0.000)	(0.000)	(0.000)		
k	0.053***	0.046***	0.047***				0.039***	0.041***	0.041***		
	(0.000)	(0.000)	(0.000)				(0.000)	(0.000)	(0.000)		
l	0.280***	0.267***	0.267***				0.242***	0.239***	0.238***		
	(0.000)	(0.000)	(0.000)				(0.000)	(0.000)	(0.000)		
Fuel Cons.	-0.006***	-0.007***	-0.007***	-7.062***	-6.803***	-7.117***	-0.007***	-0.007***	-0.007***	-5.313***	-5.387**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000
Horizontal Fuel Cons.	-1.141***		-1.241***	2.313*		2.153*	-1.623***		-1.625***	0.146	
	(0.003)		(0.006)	(0.042)		(0.100)	(0.001)		(0.008)	(0.860)	
Forward Fuel Cons.	-3.492***		-2.463**	-4.896*		1.418	2.671*		0.262	0.034	
	(0.000)		(0.014)	(0.057)		(0.633)	(0.044)		(0.908)	(0.989)	
Backward Fuel Cons.	1.386		-0.018	14.982		1.298	-1.487		-5.221**	4.961**	
	(0.101)		(0.986)	(0.000)		(0.652)	(0.220)		(0.024)	(0.022)	
Horizontal PDVSA		-157.492***	-165.52***		-1235.41***	-1205.226***		78.574	69.058		-370.69
		(0.000)	(0.000)		(0.000)	(0.000)		(0.524)	(0.599)		(0.094
Forward PDVSA		-537.694***	-624.21***		-1837.22***	-1496.339***		-2319.6***	-2296.6***		-7298.4**
		(0.000)	(0.000)		(0.000)	(0.002)		(0.007)	(0.008)		(0.000
Backward PDVSA		180.341*	296.935**		4326.49***	4011.914***		394.182	260.24		845.27
		(0.089)	(0.016)		(0.000)	(0.000)		(0.363)	(0.554)		(0.270
N	30159	25810	25810	27439	23997	23997	15679	12851	12851	13939	1155
R^2	0.9544	0.957	0.957	0.0902	0.1009	0.101	0.3582	0.39	0.3905	0.0647	0.019

All regressions include time, and regional dummies
O-P: Olley & Pakes algorithm applied
p-values in parentheses

As we mentioned, we also run an Arellano-Bond specification to cross-check there results. The results are presented in Table 2. We get the same results from the previous specification.[12]

First, here is a negative impact of productivity of using oil products as input. Following Clemente et al. (2004) we try to separate the price fro the quantity effect on this issue in Column 3. However, the result stills points out a negative impact of using oil as inputs. Secondly, there are still negative forward productivity spillovers from PDVSA's suppliers.

[12] In the appendix we show that we also did this regression with large firms only. The Venezuelan Industrial Survey is a Census of large firms and a survey for the others. The results from these estimation hold in the sample of large firms.

Table 2: Productivity and Oil. Arellando and Bond specification

Dependent Variable	Productivity					
	1	2	3	4	5	6
Lagged Productivity	0.2068***	0.2045***	0.2055***	0.2062***	0.1626***	0.1652***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fuel Cons.	-4.6488***	-4.6162***		-5.3311***	-5.4275***	-5.3856***
	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Capital Share (rK/wL+rK)		0.1533	0.1517	0.1597	0.1703	0.1727
		(0.126)	(0.129)	(0.111)	(0.124)	(0.119)
Fuel Cons. Q			-95167.31***			
			(0.000)			
Fuel P			0.0000			
			(0.161)			
Horizontal Fuel Cons.				-0.0683		-2.3542
				(0.953)		(0.106)
Forward Fuel Cons.				1.6477		-10.1631*
				(0.641)		(0.092)
Backward Fuel Cons.				14.2724***		0.1955
				(0.000)		(0.968)
Horizontal PDVSA					-632.31**	-940.1674**
					(0.048)	(0.012)
Forward PDVSA					-8649.365***	-8460.697***
					(0.000)	(0.000)
Backward PDVSA					2407.0850*	1900.5360
					(0.065)	(0.155)
Sargan test of over-identifying Restriccions (p-value)	0.0368	0.0380	0.0404	0.0339	0.3637	0.3289
N	7884	7877	7877	7877	6183	6183

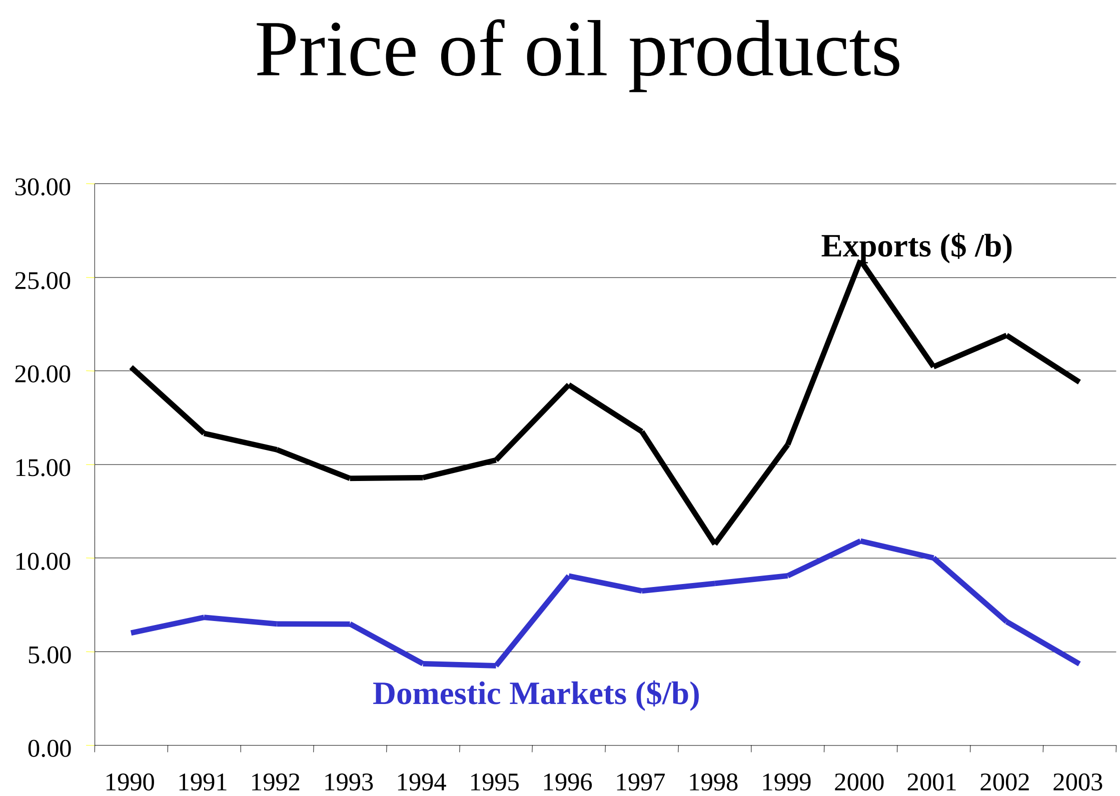
All regressions include time, and regional dummies
p-values in parentheses

These result, though different to those of Clemente et al. (2004), are more or less qualitative similar. First, using oil has a negative impact on productivity. However, there the authors argue that probably the man reason was the fact that oil in Venezuela is sold bellow market prices, as seen in Figure 3. They separate the price and quantity effects and found that the quantity effects have positive productivity effects but price effects are negative (in the sense that lower prices have negative effects. Therefore, they argue that the negative effects are associated to the policy of subsidizing oil products in the domestic market.

Our estimations found negative effects that are purely associated with the fact that a firms uses oil products as input. Cleary these estimations have a better data source than Clemente et al. (2004). Furthermore, they only test the direct effect of using oil and the horizontal effect. However, moving beyond these points an argument could be done that domestic prices have changed little as shown in Figure 3. Therefore, it could possible be that we do not have enough variation to test if the problem is price-related.

Besides the price argument, there could be other issues. One if quality of products sell to the local market compared to products sold in international markets. For example, lead-free gasoline was only begun to being sold in Venezuela in the late nineties. Also, many of the sectors that use intensively oil are either state-own, like steel production or where the state has an important share, like the Petrochemical sector, where many of the firms are Joint-Ventures between the state-own company Pequiven and local or international firms. Consequently, there could be negative effects caused by the nature of the firms, rather than the fact that firms consume oil.

Figure 3



Espinasa (2003)

With regards to PDVSA's suppliers Clemente et al. (2004) only test the Horizontal effect and found a negative effect. They argue that this shows that the policy of "buy Venezuelan product" imposed on PDVSA had a negative impact. The policy did not allow local producers to compete and therefore offer no incentive to innovate.

As we mentioned in our estimation the horizontal effect is significant and negative in some but not all the specifications. However the forward effect is significant and negative across all specifications. Consequently, we can say that the effects described in Clemente et al. (2004) move beyond the firms supplying PDVSA and are transmitted to their clients.

NOTE TO THE REVIEWER: For the conference we will have more regressions to test some of the issues discussed here like ownership, sectors, etc.

3. Oil linkages and Investment in R&D

We are also interested to find the impact of oil sector on firm's technological expenditures. To do that we have used a similar panel data from the previous exercise, this time we use a panel for the period 1995-2001 due that this panel contain a bigger set of variables that allow us to explain through both probit model and Tobit regressions what determines the decision and level of innovation expenditures at the plant-level.

In this exercise we follow a similar approach taken by Sanguinetti (2005) and Melendez and Harker (2008) to define the variables at the firm level that affect the decision to invest in R&D. We have constructed a balanced panel. We use a probit model to estimate the probability of the decisions to invest at the microeconomic level. In that sense, we create a variable dummy that takes the value 1 at time t if we observe a positive realization of technological expenditures, and zero otherwise.

In this regard, explanatory variables are proxies of what factor impacts on firm's innovation expenditures. We have include into this exercise employment to capture the effect of the correlation between technological expenditures and size, while employment square is also include to confirm that this relation is no linear. Foreing Capital participation was added to see how innovation expenditures could vary with the structure of ownership of the firm. In addition, the ISIC 3-digit Herfindahl-Hirshman Index (HHI) of market concentration was constructed to find the ambiguous effects of concentration.

The impact on innovation from changing tax rules was captures using the standard deviation over time of the tax rate effectively paid by each firm. While the effect of transport infrastructure was captured through total kilometers on the states where firms are located.

Also, to see the correlation between the plant-level decisions and the macroeconomic performance we have decided to included the previous Gross Domestic Product growth of the state where the firm is locate. While we try to capture the effect of high financing cost by a measure that multiplied a one lag period lag of the lending rate by the ratio between financial liabilities over total liabilities of each firm in each period.

Finally but more importantly, we have included a set of variables to capture both direct and indirect effect of oil sector on the firm-level decision through backward and forward linkages, as well horizontal spillovers that were explained in the previous exercise. In addition, we define a variable that reports the effect of oil consumption as a proportion of the total gross output of each firm. Also, since investment decision of firm is more likely to be affected by oil production, we matched the oil production of each state to the state where the firm is located and included as explanatory variable.

Table 3: Probability to invest in R&D

Dependent Variable	Dummy=1 if firm reports positive R&D expenditures (Probit regression)							
	1		2		3		4	
			(all firms)					
Total Employment	0.00149	***	0.00150	***	0.00160	***	0.00164	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Employment square	-1.390E-07	***	-1.390E-07	***	-1.550E-07	***	-1.590E-07	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Foreing Capital Participation	0.00209	***	0.00206	***	0.00280	***	0.00323	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Herfindahl Index			-0.02602		-.0417929		-.0363287	
			(0.024)	**	(0.113)		(0.152)	
standar deviation Tax by ciiu			0.00000		-1.39e-07		-1.14e-07	
			(0.458)		(0.596)		(0.689)	
Skill			-.0939617		-.0640277		-.0792227	
			(0.126)		(0.430)		(0.395)	
Transports Cost (Total vial)							-.0000402	**
							(0.020)	
state gdp growth							-.0009362	
							(0.997)	
Lending rate*Financial debt							.005223	
							(0.222)	
Rigid Labor							.3637921	
							(0.100)	
Forward Cons. Fuel					-12.29869	*	-18.40424	**
					(0.085)		(0.021)	
Backward Cons. Fuel					13.70214	*	12.35087	*
					(0.043)		(0.085)	
Horizontal Cons. Fuel					-6.195295	*	-5.50713	
					(0.066)		(0.133)	
Cons. Fuel					-.0141404		-.0273746	
					(0.887)		(0.807)	
Local oil prod.					1.92e-07		6.87e-07	***
					(0.264)		(0.009)	
Forward pdvsa					913.9385		1032.278	
					(0.597)		(0.618)	
Backward pdvsa					-20.10039		249.2376	
					(0.986)		(0.852)	
Horizontal PDVSA					-489.1349		-407.6372	
					(0.205)		(0.346)	
constant	-1.91100	**	-1.86063	***	-2.00619	***	-2.31420	***
	(0.000)		(0.000)		(0.000)		(0.000)	
wald chi2	240.26		247.77		182.56		171.58	
log likelihood	-5830.2724		-5824.8000		-4080.5488		-3340.1202	
N	18542		18539		13243		10587	

p-values in parentheses. All specifications include time dummies

Table 4: Investment in R&D

Dependent Variable	Dummy=1 if firm reports positive R&D expenditures (Probit regression)							
	1		2		3		4	
	(all firms)							
Total Employment	0.1368	***	0.1380	***	0.0836	***	0.0964	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Employment square	-1.310E-05	***	-1.320E-05	***	-8.130E-06	***	-9.760E-06	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Foreing Capital Participation	0.2026	*	0.2036	*	0.3646	***	0.4417	***
	(0.059)		(0.058)		(0.000)		(0.000)	
Herfindahl Index			0.0000		-9.98e-06		-.0000127	
			(0.441)		(0.750)		(0.738)	
standar deviation Tax by ciiu			-1.8425		-.6821769		-.4634156	
			(0.230)		(0.647)		(0.772)	
Skill			8.466415		5.018257		10.20532	
			(0.407)		(0.589)		(0.371)	
Transports Cost (Total vial)							-.001114	**
							(0.598)	
state gdp growth							-18.46746	
							(0.569)	
Lending rate*Financial debt							.0596013	
							(0.917)	
Rigid Labor							30.54242	
							(0.211)	
Forward Cons. Fuel					-1027.103		-1005.41	
					(0.194)		(0.260)	
Backward Cons. Fuel					1958.311	**	1917.261	**
					(0.012)		(0.030)	
Horizontal Cons. Fuel					-619.2942	*	-564.2179	
					(0.100)		(0.100)	
Cons. Fuel					-.1719291	*	-.0385264	
					(0.084)		(0.765)	
Local oil prod.					.0000448	**	.0000646	**
					(0.026)		(0.050)	
Forward pdvsa					11566.83		-2170.364	
					(0.954)		(0.993)	
Backward pdvsa					-22871.47		12486.61	
					(0.863)		(0.941)	
Horizontal PDVSA					-17674.19		-24630.06	
					(0.678)		(0.627)	
constant	42.3473	***	-1.8606	***	49.2386	***	17.9081	
	(0.000)		(0.000)		(0.000)		(0.524)	
wald chi2	115.64		118.49		115.87		73.4	
log likelihood	-137083.5000		-137061.3400		-94006.1670		-75993.0040	
N	18542		18539		13243		10587	

p-values in parentheses. All specifications include time dummies

In Table 3 we present the results. From the table we see that some of the coefficients are significant and as expected. With respect to oil, we found that direct links to the oil sector does not seem to affect the likelihood to invest in R&D. However, there are spillover effects. In particular, firms forwardly related to firms that consume oil are less likely to invest in R&D while firm that supply those firms are more likely to invest. Finally, firms in oil producing states are more likely to invest in R&D if there are increases in oil production.

Extending further these results, in Table 4 we do a Tobit model to explain the investment in R&D. In general, the results from the previous Table hold, though the significance of most of the coefficient is less. We found that direct links to the oil sector does not seem to affect the likelihood to invest in R&D. However, there are spillover effects. In particular, firms backwardly related to firms that consume oil will invest more in R&D. Finally, firms in oil producing states tend to invest more if there are increases in oil production.

These results could suggest that the effects of the policies described in the previous section are present. The fact that firms that supply and but form firms that use oil as an input have different probabilities and amounts of investment in R&D could reflect price incentives. If oil is sold cheaply, firms linked forwardly with firms that use oil as input would be less likely to invest in R&D if part of the low price of oil is transmitted to them. Similarly, firms linked backwardly, have to compete with another cheap input an will be more likely to invest in R&D.

The results show some contrast with the previous section. Firstly, the likelihood of investing more on R&D is not reflected in higher productivity gains.[13] There is evidence that R&D investment might have lagged effects on productivity.[14] Therefore, a plausible explanation is that we are not capturing these effects.

On the other hand, the negative effects that we found in the previous section are not related to the likelihood and amount of investment in R&D. This could imply that the productivity effects are associated with the use of resources, rather than the investment in R&D for higher productivity.

NOTE TO THE REVIEWER: For the conference we will have more regressions to test some of the issues discussed here like lags, sectors, etc.

4. Concluding remarks

There is an ongoing debate on the role played by natural resources in development. Among the different issues of concern to researchers and policy makers is the role played by the resource sector on industrial performance. Different case studies have found that developed countries that were or are resource abundant took advantage of the resource sector as a center of a cluster for diversification. These studies highlight the role played by institutions around the resource sector, the development of human capital around the sector, and an environment conducive to accumulate knowledge capital. However, this

[13] The time frame for the regressions for R&D is different to those in Section 2. Nevertheless, in the appendix we repeat the regressions of section 2 in the time frame that we have data for R&D and the results hold.

[14] Benavente and De Gregorio (2004)

has not been the case in Latin American countries where the resource sector was seen as an “enclave” and no significant linkages were developed.

In this paper we empirically review the role played by the Venezuelan oil sector in fostering productivity in the manufacturing sector. We use the Manufacturing Survey of Venezuela to find productivity spillovers from the resource sector. We also test if the resource sector fosters investment in R&D.

We found that there are some negative productivity effects of using oil as an input. Furthermore, there are negative spillovers. Firms forwardly linked to firms that supply PDVSA, the local oil company, suffer from negative spillovers.

With regards to the likelihood and amounts of investment in R&D, we found positive and negative effects. Firms forwardly related to firms that consume oil are less likely to invest in R&D while firm that supply those firms are more likely to invest. The result holds in term of amount of investment for firms that supply firms that use oil as an input.

In the paper we argue that these results seem to be related to policy decisions taken in Venezuela. On one side, domestic price of oil products are heavily subsidized. Therefore, this could lead to an inefficient use of resources. Also, the Venezuelan oil company was forced to buy locally. This could also reduce the incentives of local firms to improve the quality of their products.

These results shed some light on the policy mix used to link the local economy with the resource sector. Policies based on subsidies that have no incentives to become more competitive as well as policies that lack of an “exit strategy” might achieve opposite outcomes than those targeted by the intervention. Therefore, it is important that policy makers in less developed countries take these issues into consideration when designing policies geared towards the development of a non-resource sector.

5. References

Adriani, A. (1931). La Crisis, los cambios y nosotros. En H. Valecillos y O. Bello (eds.), (1990). La Economía Contemporánea de Venezuela. Ensayos Escogidos, Tomo I. Caracas: Banco Central de Venezuela.

Arellano, Manuel and S. Bond (1991) "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", Review of Economic Studies, 58, 1991, 277-297.

Blomström, M. y Kokko, A. (2002). From natural resources to high-tech production: the evolution of industrial competitiveness in Sweden and Finland. EIJS Working Paper Series No. 139 (mimeo). European Institute of Japanese Studies.

Blyde et al (2004), Exporting vs. Outsourcing by MNC Subsidiaries: Which Determines FDI Spillovers? Inter-American Development Bank.

Clemente, L. (2001). The international competitiveness dynamic and the economic progress in Venezuela. Paper presentado al Arturo Uslar Pietri Chair en la UNIMET. Caracas: Universidad Metropolitana.

Clemente, L., Manzano, O. y Puente, A. (2005). Oil sector impact on industrial productivity in Venezuela (mimeo). Caracas: Corporación Andina de Fomento.

Corden, W. M. y Neary, J. P. (1982). Booming sector and de-industrialisation in a small open economy. The Economic Journal, 92(368), 825-848.

Hausmann, R. y Rodrik, D. (2003). Economic Development as Self Discovery. NBER Working Paper No. 8952. Cambridge: National Bureau of Economic Research.

Hausmann, Ricardo (2003). “Venezuela’s Growth Implosion: A Neo-Classical Story?” in Rodrick, Dani, ed, 2003, *In Search of Prosperity*. Princeton University Press.

HIRSCHMAN, A., "A Generalized Linkage Approach to Development with Special Reference to Staples," Economic Development and Cultural Change 25, 1977.

Lederman, Daniel and William Maloney, ed., 2006, *Natural Resources and Development: Neither Curse nor Destiny,* Stanford University Press and The World Bank, Stanford.

Maloney, William, 2002, "Missed Opportunities: Innovation and Resource-Based Growth in Latin America", Economia, Vol. 3 No. 1, pp 111-151.

Manzano, O. (2009), "Venezuela after a century of oil exploitation" in Hausmann, R y F. Rodriguez, editores, por publicarse, Venezuela; Anathomy of a Collapse, Penn State University Press.

Manzano, Osmel, 2008, "El rol de los Recursos Naturales en el Desarrollo de América Latina", in José Luis Machinea y Narcís Serra (Eds.), Hacia un nuevo pacto social. Políticas económicas para un desarrollo integral en América. Santiago de Chile: Naciones Unidas. CEPAL; Barcelona: Fundació CIDOB,

Melendez, Marcela and A. Harker (2008), "Revisiting Economic Growth in Colombia – A Microeconomic Perspective. Inter-American Development Bank

Ministerio de Energía y Minas (MEM) (various years), "Petróleo y Otros Datos Estadísticos", Dirección de Economía e Hidrocarburos, Caracas.

Noland, M. y Pack, H. (2002). Industrial Policies and Growth: Lessons from International Experience. En N. Loayza y R. Soto (eds.), (2002). Economic Growth: Sources, Trends, and Cycles. Santiago: Banco Central de Chile.

Olley, Steve and Ariel Pakes (1996), "The Dynamics of Productivity in the Telecommunications Equipment Industry," Econometrica, vol. 64, no. 6, pp.1263-98

Peltzer, E. (1944). La industrialización de Venezuela y el alto tipo de cambio del Bolívar. En H. Valecillos y O. Bello (eds.), (1990). La Economía Contemporánea de Venezuela. Ensayos Escogidos, Tomo I. Caracas: Banco Central de Venezuela.

Peraza, Javier, 1999, "Análisis de Algunos Aspectos de la Economía Venezolana usando modelos Insumo-Producto," *manuscrito,* Oficina del Economista Jefe, Petróleos de Venezuela (PDVSA).

Prebisch, Raúl, 1950, "The Economic Development of Latin America and its Principal Problems, reprinted in *Economic Bulletin for Latin America,* Vol. 7, No. 1, 1962, 1-22.

Sachs, Jeffrey y Andrew Warner, 1995, "Natural Resource Abundance and Economic, Growth", *NBER Working Paper n. 5398,* NBER, Cambridge.

Sachs, Jeffrey y Andrew Warner, 1997, "Natural Resource Abundance and Economic, Growth", *manuscrito inédito,* CID-Harvard, Cambridge.

Salter, W.E.G., 1959, "Internal and External Balance: The Role of Price and Expenditure Effects", *Economic Record,* vol. 53, 226-238

Sanguinetti, Pablo (2005), "Innovation ad R&D expenditures in Argentina: Evidence from a firm level survey". Universidad Torcuato Di Tella.

Stijns, Jean-Philippe, 2003, "An Empirical Test of the Dutch Disease Hypothesis using a Gravity Model of Trade,"", *mimeo*, UC Berkley.

Wright, G. y Czelusta, J. (2002). Resource-based growth past and present (mimeo). Stanford University.

Appendix 1: Larg firms sample

Appendix 2: Productivity in the R&D Sample (1995-2001)

Table X: BKS specification. Use of oil products

All Plants	Levels		1st Differences	
		O-P		O-P
ci	0.5959501		0.3791552	
	(0.000)		(0.000)	
k	0.1065791		0.0572009	
	(0.000)		(0.000)	
l	0.4135775		0.2547041	
	(0.000)		(0.000)	
ccombpbruta	-0.0063515	-4.659398	-0.0065753	-3.601157
	(0.000)	(0.000)	(0.000)	(0.000)
Horizontal	0.3243947	1.694276	-1.357789	-0.1028543
	(0.656)	(0.210)	(0.071)	(0.931)
Forward	-5.786297	-11.77607	1.60866	-0.7146524
	(0.000)	(0.057)	(0.382)	(0.806)
Backward	12.53325	6.756047	-0.2274818	3.873787
	(0.101)	(0.000)	(0.901)	(0.156)
N	14991	14337	8220	7737
R^2	0.9232	0.3653	0.3412	0.0204

All regressions include time, and regional dummies
O-P: Olley & Pakes algorithm applied
p-values in parentheses

Table X: BKS specification. PDVSA Supplies

All Plants	Levels		1st Differences	
		O-P		O-P
ci	0.597949		0.4053173	
	(0.000)		(0.000)	
k	0.1042618		0.0626763	
	(0.000)		(0.000)	
l	0.4042565		0.2510802	
	(0.000)		(0.000)	
ccombpbruta	-0.006358	-4.3763	-0.006528	-4.419735
	(0.000)	(0.000)	(0.000)	(0.000)
Horizontal	-519.2119	-1175.969	-12.57585	-49.50793
	(0.000)	(0.000)	(0.945)	(0.865)
Forward	76.6431	1049.366	-4231.925	-7266.799
	(0.817)	(0.080)	(0.007)	(0.000)
Backward	2110.991	2835.302	1041.497	918.0167
	(0.089)	(0.000)	(0.054)	(0.277)
N	12807	12291	6742	6321
R^2	0.925	0.0738	0.3885	0.019

All regressions include time, and regional dummies
O-P: Olley & Pakes algorithm applied
p-values in parentheses

Table X: BKS specification. Both effects

All Plants	Levels		1st Differences	
	O-P		O-P	
ci	0.6017		0.4053583	
	(0.000)		(0.000)	
k	0.1029772		0.0621995	
	(0.000)		(0.000)	
l	0.4035935		0.2499775	
	(0.000)		(0.000)	
ccombpbruta	-0.0063625	-4.689304	-0.0065286	-4.414017
	(0.000)	(0.000)	(0.000)	(0.000)
Horizontal	-0.5837779	-0.4170328	-2.273171	-1.069418
	(0.006)	(0.765)	(0.043)	(0.547)
Forward	-3.843057	-7.043492	3.077338	0.0456101
	(0.014)	(0.011)	(0.333)	(0.993)
Backward	12.33562	6.788953	-3.475326	-4.726107
	(0.986)	(0.010)	(0.305)	(0.356)
Horizontal PDVSA	-470.3013	-1086.719	64.94195	-66.0864
	(0.000)	(0.000)	(0.762)	(0.848)
Forward PDVSA	972.7827	1784.309	-4135.833	-7051.853
	(0.000)	(0.002)	(0.000)	(0.000)
Backward PDVSA	1117.106	2248.833	649.1951	670.3646
	(0.016)	(0.000)	(0.267)	(0.464)
N	12807	12291	6742	6321
R^2	0.9258	0.0768	0.3865	0.0192

All regressions include time, and regional dummies

O-P: Olley & Pakes algorithm applied

p-values in parentheses

Table X: Arellano Bond specification

Dependent Variable	Productivity						
	1	2	3	4	5	6	6
Lagged Productivity	0.3571182	0.3596297		0.3997205	0.3997137	0.3971677	0.3965177
	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
ccombpbruta	-2.31431	-2.33433		-3.07531	-3.985956	-3.888116	-3.895252
	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Capital Share (rK/wL+rK)		-0.1028759		-0.1153741	-0.1111984	-0.1157606	-0.1177966
		(0.173)		(0.156)	(0.236)	(0.214)	(0.206)
ccombq							
ccombp							
Horizontal				-.2623008		-3.972493	-3.899851
				(0.818)		(0.048)	(0.053)
Forward				6.325723		3.459418	3.709963
				(0.029)		(0.528)	(0.537)
Backward				4.725266		-10.85757	-10.9534
				(0.125)		(0.024)	(0.023)
Horizontal PDVSA					-643.3608	-568.4706	-581.7699
					(0.072)	(0.136)	(0.127)
Forward PDVSA					-6988.48	-6948.516	-6928.552
					(0.029)	(0.036)	(0.036)
Backward PDVSA					1717.453	1247.251	1264.439
					(0.248)	(0.385)	(0.379)
R&D/employees							.0000509
							(0.067)
Lagged R&D/emplyees							3.69e-06
							(0.990)
Sargan test of over-identifying restriccions							
Arellano-Bond test that average autocovariance in residuals of order 1 is 0							
Arellano-Bond test that average autocovariance in residuals of order 2 is 0							
N	5366	5359		4492	3529	3529	3529